CM-42 Integrator's Manual

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Revision History

RELEASE	DATE	SUMMARY OF CHANGES
PA6	10/19/01	Incorporation of comments from 10/16/01 design team meeting
PA7	10/23/01	Update Power Consumption (sections 4.2.3.1 – 4.2.3.2)
PA8	10/26/01	Update Developer's Board Outline, AT commands, and other from design team review
PA9	12/13/01	Update to AT commands (AT+COS, AT*EUNSOL, AT+CPAS, AT*ECAM, AT*ENSERV, AT*ECBAR), removed AT commands (AT*ENAUD, AT+CAU, AT+CPSR, AT+CPTC, AT+CPER), updated board dimensional and outline drawing, updated support e-mail address, plus other items from review
PA10	02/06/02	Complete update of manual
A	04/02/02	Removed AT Command, Use Cases and Developer's Board sections. Updated Customer Support Contact Information. New Document Number.
B	06/18/2003	Exchanged Pins 19 and 20 to make CM-42 compatible with the M2MCom portfolio.
C	08/01/2003	Updated Power Levels, System Connector Interface, corrected grammar and added diagnostics section.

1 Introduction to the Integrator's Manual

1.1 Overview

This manual is for use as a guide to the setup, installation, and use of the CM-42 module into your application. The module may be tested using the Developer's board, which is supplied together with all the necessary tools in the Developer's Kit.

The CM-42 module is intended for mounting into an application developer's chassis to provide wireless communication capability for the product. The target chassis could be in a wide variety of forms such as a residential electric meter, a point of sale terminal, an alarm panel, or an automobile console. All initial configuration, mode control, and operational commands are issued to the module over an RS-232 serial port using a flexible AT command format. The module circuitry has been designed to meet the environmental requirements of a large range of commercial and industrial users.

1.2 How to read the manual

This manual is divided into two chapters. **Chapter 1** gives a general overview of the integrator's manual and the intended use of the CM-42 module. A list of related documents as well as a list of abbreviations, used throughout the manual, is also included. Information concerning Service and Support is also presented.

Chapter 2 focuses on helping the hardware developer integrate the CM-42 hardware into their application. An overview of the mechanical and electrical information is provided. Also, interface specifications, RF output Power Class, power consumption, and recommended application circuits are included in this chapter. A section briefly describing several of the common cellular functions is also provided. A summary of the mechanical dimensions, power requirements and environmental specifications can be found at the end of the chapter.

1.3 Service and Support

1.3.1 Web Pages

Please look at our web pages for more information about where you can buy our modules or for recommendations of accessories and components.

The address is:

http://www.SonyEricsson.com/M2M/

To register for product news and announcements or for product questions, contact the Sony Ericsson modules Technical Support group:

- **Telephone**: 919-472-1122 (staffed Monday-Friday 9:00 AM – 5:00 PM EST).
- **Email**: Modules.SupportUSA@SonyEricsson.com

1.3.2 Component Suppliers

Description	Vendor / Part #	Additional Information
System Connector	ODU / 515.569.035.140.xxx	http://www.odu.de
Fakra Antenna Connector and cabling	ITT Cannon / Various	Http://www.ittcannon.com
Fakra Antenna Connector and cabling	Hirschmann / Various	http://www.hirschmann.com
Fakra Antenna Connector and cabling	Amphenol RF / Various	http://www.amphenolrf.com

1.4 Related Documents

CM-42 AT Command Manual - Details the AT command interface for the CM-42.

The CM-42 is based upon the following mobile standards:

- IS-2000 Release 0 (1XRTT), MOB_P_REV 6 - *CDMA protocol*
- TIA/EIA/IS-91 – *Mobile Station - Base Station Compatibility Standard for 800 MHz Analog Cellular*
- TIA/EIA-98-D - Recommend Minimum Performance Standards for Dual-Mode Spread Spectrum Mobile Stations

These standards define the requirements for a PCS / Cellular System mobile station using Code Division Multiple Access (CDMA) technology while maintaining compatibility with AMPS analog technology.

1.5 Abbreviations

AGND	Analog Reference
AT	Attention command
CTS	Clear To Send
DCD	Data Carrier Detect
DFMS	Data From Mobile Station
DTMS	Data To Mobile Station
DTR	Data Terminal Ready
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
GND	Chassis GrouND
IRA	International Reference Alphabet
LSB	Least Significant Bit
ME	Mobile Equipment
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
OEM	Original Equipment Manufacturer
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PIN	Personal Identification Number
RD	Receive Data, also known as DFMS
RF	Radio Frequency
RTS	Request To Send
SMS	Short Message Service
TD	Transmit Data, also known as DTMS

2 Integrating the CM-42 Module

2.1 Overview

The CM-42 is a dual band CDMA/AMPS 800 and CDMA 1900 MHz transceiver module. It is designed for consumer and OEM industrial voice and data applications.

The CM-42 module is intended for mounting into an application developer's chassis to provide wireless communication capability for the product. The target chassis may take a wide variety of forms such as a residential electric meter, a point of sale terminal, an alarm panel, or an automobile console. All initial configuration, mode control, and operational commands are issued to the CM-42 module over an RS-232 serial port using a flexible AT command format, as described in the CM-42 AT Command Manual.

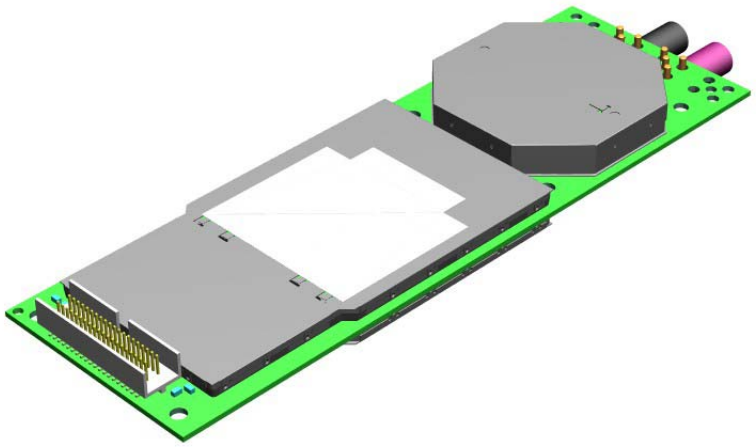


Figure 1: CM-42 Mechanical Drawing

2.2 Mechanical Description

The CM-42 has no mechanical elements other than the main PCB assembly. All critical electronic components are shielded using sheet metal cans to prevent internal and external electromagnetic interference from degrading the module's performance and to prevent the module from interfering with other nearby devices. The module is plugged into the fixed mating connector and secured with 8 screws to the standoff posts.

The module has no keypad, display, microphone, speaker or battery. The physical dimensions of the CM-42 module are as indicated in the figure shown below.

Note! All the measurements are in millimeters.

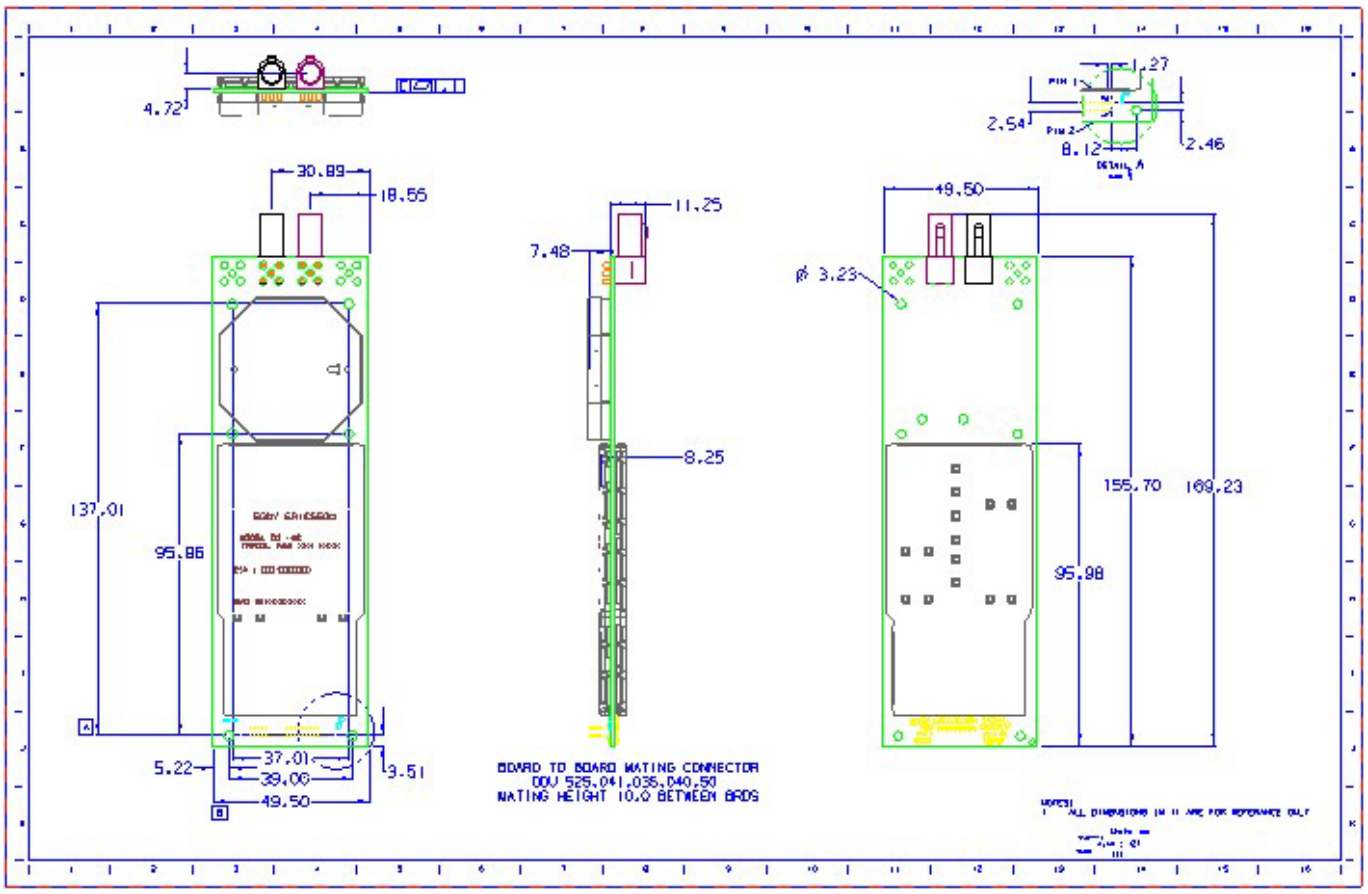


Figure 2: Physical Dimensions of the CM-42

2.3 System Connector Interface

2.3.1 Overview

External interfaces to the module are made primarily through a 40-pin, standard 0.050-inch pitch, ODU header shown below.

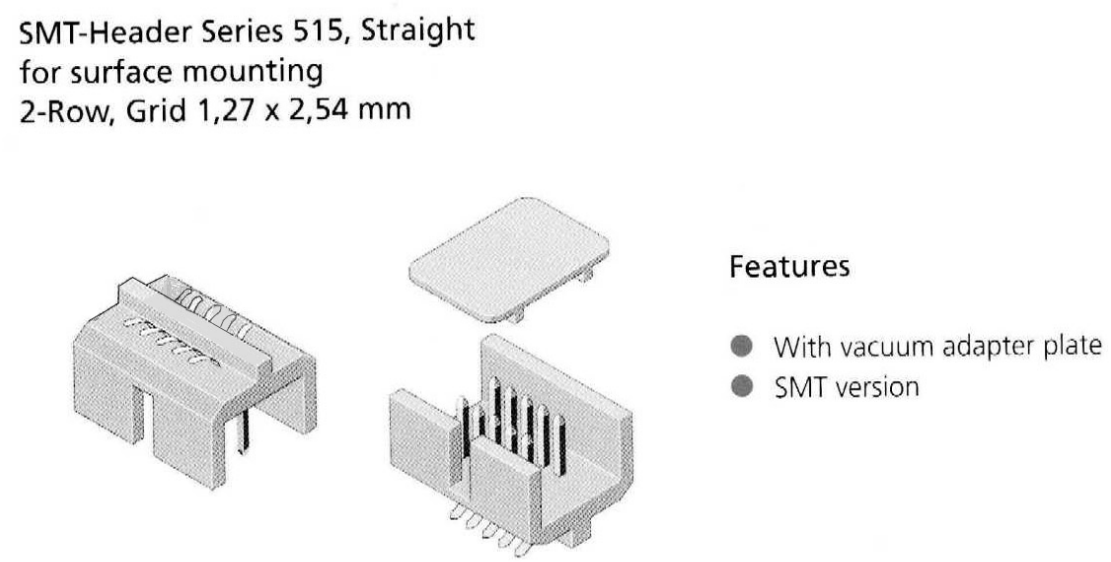


Figure 3: 40-pin system connector

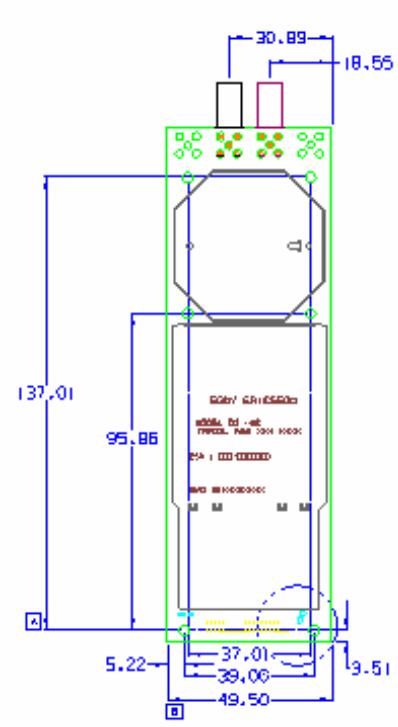


Figure 4: Pin positions in 40-pin system connector

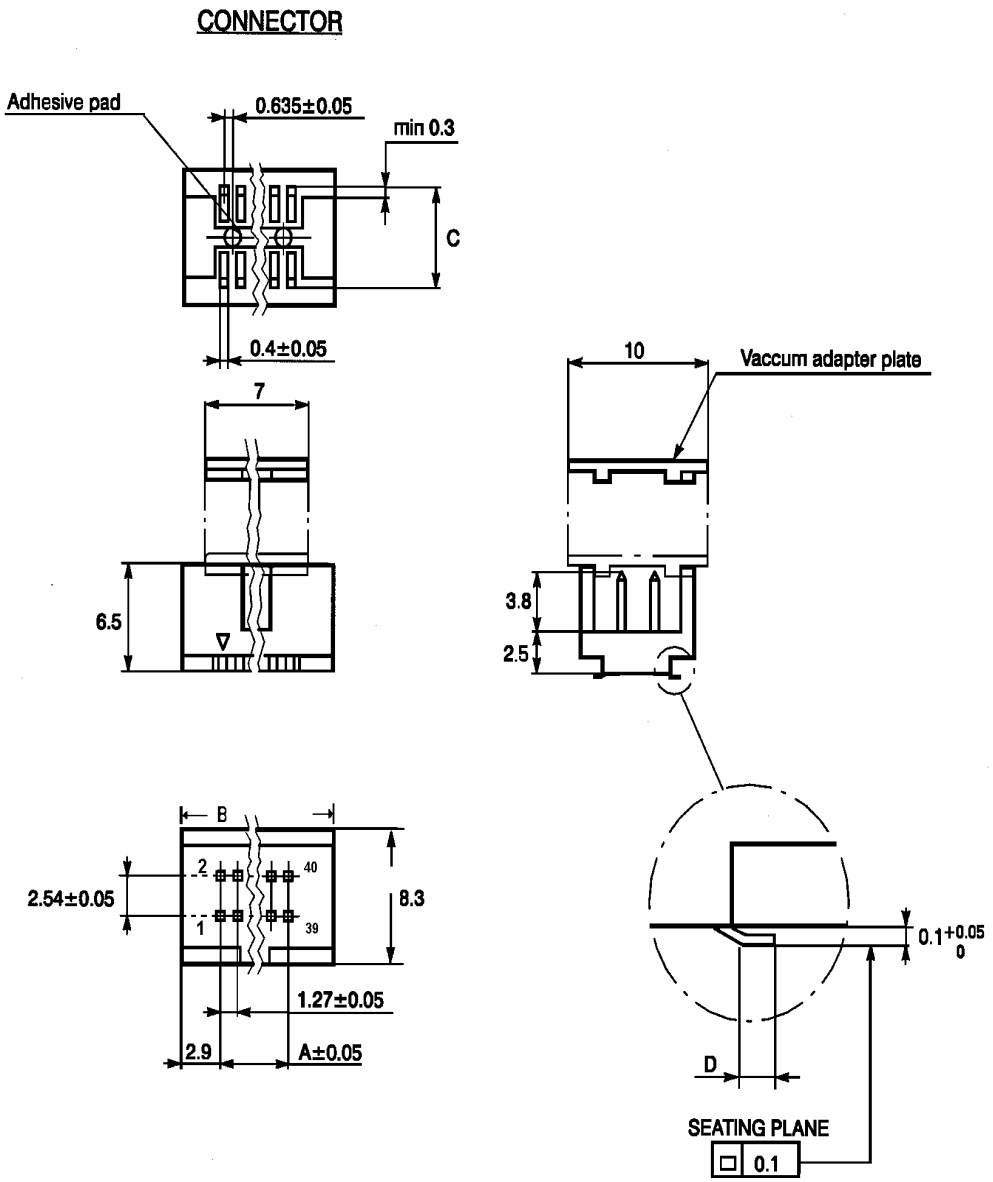


Figure 5: 40-pin system connector footprint

Table 1 shows the PIN-connection of the different signals connected to the interface as well as a short description of the signals.

Pin	Signal	Description
1	I/O_1	General Purpose Binary Input / Output # 1
2	VREF	Logic Voltage Reference
3	I/O_3	General Purpose Binary Input / Output # 3
4	I/O_4	General Purpose Binary Input / Output # 4
5	GND	Chassis Ground
6	GND	Chassis Ground
7	AFMS	Audio from module
8	GND	Chassis Ground
9	AGND	Analog Reference
10	ATMS	Audio to module
11	INPUT1	General Purpose binary input #1
12	MODULE_PWR_EN_B	Switches the module on/off (hardware-wise), active low
13	OUTPUT1	General Purpose binary output #1
14	OUTPUT2	General Purpose binary output #2
15	HW_SD	Hardware shutdown
16	INPUT2	General Purpose binary input #2
17	PCMCLK	PCM Clock output from Module to Application
18	PCMSYNC	PCM Frame sync from Module to Application
19	PCMULD	PCM Voice input to Module from Application
20	PCMDLD	PCM Voice output from Module to Application
21	GND	Chassis Ground
22	GND	Chassis Ground
23	DCD / VPPFLASH	Data Carrier Detect & Flash programming voltage input
24	RINGER	Ringer output
25	CTS	Clear to send
26	DTR	Data Terminal Ready
27	TD	Transmit data, also known as DTMS
28	RTS	Request to Send
29	VCC_AUX	13.8 VDC supply voltage (needed for Band Class 0, Mobile Station Class I operation)
30	RD	Receive data, also known as DFMS
31	VCC_AUX	13.8 VDC supply voltage (needed for Band Class 0, Mobile Station Class I operation)
32	VCC_AUX	13.8 VDC supply voltage (needed for Band Class 0, Mobile Station Class I operation)
33	VCC_MAIN	5 VDC regulated supply voltage
34	VCC_MAIN	5 VDC regulated supply voltage
35	Reserved	Reserved
36	Reserved	Reserved
37	CTMS	Reserved
38	Reserved	Reserved
39	CFMS	Reserved
40	RI	Ring Indicator

Table 1: Pin-out of the System Connector Header

2.3.2 General Electrical and Logical Characteristics

Many of the signals present in the interface are CMOS signals where the following levels apply. The Nominal Voltage Level for the CMOS signals is 2.9 V.

Parameters	**Test conditions**	**Limits**		**Units**
		Min.	**Max.**	
High level output voltage (I_{OH}= 800 μA)	V_{OH}	2.45	3.1	Volts
Low level output voltage (I_{OL}= 800 μA)	V_{OL}	0	0.45	Volts
High-Level Input Voltage (V_{IH})	V_{IH}	1.9	3.1	Volts
Low-Level Input Voltage (V_{IL})	V_{IL}	0	0.9	Volts

Table 2: CMOS Output / Input electrical characteristics

2.3.3 Nominal Output Power Levels

The CM-42 is able to operate in several modes and different output power levels. Applications may require output power levels similar to those in a handheld cellular phone or higher levels commonly required when in rural areas. Table 3: Mobile Station Nominal Analog Power Levels below shows the nominal output power levels of the CM42. (Effective Radiated Power, assuming a maximum antenna system gain of 1 dBi (2.5 dBi antenna gain with 1.5 dB cable loss)).

	Mobile Station Power Level (dBm)							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Class I, AMPS	34.8	31	26.3	24	20	16	12	8

Table 3: Mobile Station Nominal Analog Power Levels

***Note: Analog Output power levels maintained within a range of +2 / -4 dB for PL0-7**

	Mobile Station Power Level (dBm)	
	Lower Limit	Upper Limit
Class III, CDMA Band Class 0	23 dBm (0.2 Watts)	30 dBm (1.0 Watts)
Class II, CDMA Band Class 1	23 dBm (0.2 Watts)	30 dBm (1.0 Watts)

Table 4: Mobile Station CDMA Maximum Output Power

2.3.3.1 Power Consumption

Operational Mode Currents (All measurements are in mA unless otherwise noted)		5.0 V ±10%		13.8 V ±20%	
		Average	Transient Peak	Average	Transient Peak
AMPS	Voice Channel PL0	550	650	700	1300
	Voice Channel PL2	850	920	4.5	-
	Standby (waiting for page)	45	-	4 uA	-
CDMA	Traffic Channel (800/1900MHz)	700/850	1000	4.5	-
	Standby (waiting for page)	4.0	-	4 uA	-

Table 5: Power Consumption

2.3.3.1.1 Power Down Mode (Minimum DC Power consumption)

A power down mode is available in which the module is placed in a low power consumption state under control of the host application. In this mode, the unit consumes approximately 110 uA of current as measured from the VCC_MAIN supply input and 4 uA of current as measured from the VCC_AUX supply input. To activate this mode, the Module_PWR_EN_B signal on pin 12 of the system connector is pulled to a logic level 1, which puts the module into the low power state. The module will stay in the low power state until the Module_PWR_EN_B signal is driven low by an external open collector transistor in the application circuitry. Turning the external open collector transistor off will cause the Module_PWR_EN_B signal to float high and turn the module off. The Module_PWR_EN_B line is tied to VCC_MAIN through a 220kΩ pull-up resistor so the sink current in the external open collector transistor is minimal.

2.3.3.2 Power Supply and Ground Signals

Two separate voltages are required to power the module and are detailed below.

VCC_AUX: 13.8 V ± 20%. 1.3 A max. Ripple: 0-4KHz @ 600mVpp, 4 KHz-10MHz @ 240mVpp
VCC_MAIN: 5 V ± 10%. 1.0 A max. Ripple: 0-4KHz @ 100mVpp, 4 KHz-10MHz @ 50mVpp

Following is a list of the power supply pins:

Pin	CM-42 Signal	Description
29	VCC_AUX	13.8 volt ± 20%, 0.5A max
31	VCC_AUX	13.8 volt ± 20%, 0.5A max
32	VCC_AUX	13.8 volt ± 20%, 0.5A max
33	VCC_MAIN	5 volt ± 10% regulated, 0.5A max
34	VCC_MAIN	5 volt ± 10% regulated, 0.5A max

Table 6: CM-42 Power Supply Signals

The ground signal in the CM-42 is Digital Ground, **GND**, connected to the system connector interface through pin numbers 5, 6, 8, 21 and 22.

Following is a list of the ground pins:

Pin	CM-42	Description
5	GND	Digital Ground
6	GND	Digital Ground
8	GND	Digital Ground
21	GND	Digital Ground
22	GND	Digital Ground

Table 7: CM-42 Ground Signals

Chassis Ground (GND)

- GND is the logical reference of all digital signals in the System Interface as well as the DC return of the power supply signal, VCC_MAIN and VCC_AUX (used for AMPS Class I operation).
- Electrical characteristics: $I_{average} < 0.7$ A $I_{peak} < 2$ A

Note: No single GND pin can withstand over 0.5 A.

2.3.3.3 Module_PWR_EN_B

The Module_PWR_EN_B signal is a TTL compatible active high input. The Module_PWR_EN_B pin is tied to VCC_MAIN through 220kΩ resistor. An open collector/drain transistor is recommended to control this signal in the application. Short this signal to GND to power up the module, allow the signal to float to power down the module.

2.3.4 Audio Interface

The audio-related signals are: the analog audio signals

- **ATMS** (Audio to Mobile Station),
- **AFMS** (Audio from Mobile Station),
- **PCM** (Pulse Code Modulation) signals (**PCMULD**, **PCMDLD**, **PCMCLK**, and **PCMSYNC**).

Pin	CM-42	Description
7	AFMS	Audio Output From Module.
10	ATMS	Audio Input to Module.
9	AGND	Analog Reference
17	PCMCLK	PCM Clock Output from module.
18	PCMSYNC	PCM Frame Sync Output from module.
19	PCMULD	PCM Voice Input to module
20	PCMDLD	PCM Voice Output from module.

Table 8: CM-42 Audio Signals

2.3.4.1 Analog Audio

ATMS (pin 10 in the system connector) is the analog audio input to the module. When it is active, it is connected to the radio via the audio processing stages in the module.

The AFMS (pin 7 in the system connector) is the analog audio output from the module. When it is active it is connected to the radio via the audio processing stages in the module.

The AGND (pin 9 in the system connector) is the analog reference signal. ATMS and AFMS are referenced to this signal, which is connected to GND in one place inside the module.

Pin	CM-42	Description
7	AFMS	Audio Output From Module
10	ATMS	Audio Input To Module
9	AGND	Analog Reference

Table 9: CM-42 Analog Audio Signals

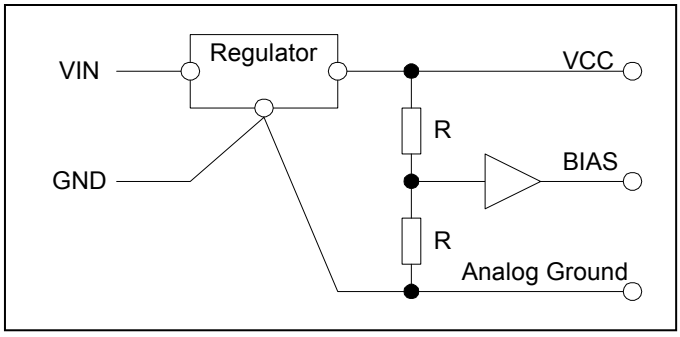
AFMS	**Module audio output**	300 – 3400 Hz
	Output Impedance	Rout 100 Ω
	Drive capacity into 10 kΩ	3.77 V_{P-P} max. or 2.5 dBV
	External Device audio input impedance	Zin ≥ 10 kΩ
	Volume control	-81 dB from maximum > - 81 dB (mute)
	Sensitivity	1004 Hz tone at 8kHz deviation generates 900±100 mV_{rms}.
ATMS	**Sources are preferably AC coupled.**	Cout ≥ 2.2uF
	External Device audio source Output resistance	Rout ≤ 1.0 kΩ
	Module audio input impedance	Zin ≥ 10 kΩ
	Levels from external audio source (maximum)	3.77 V_{P-P} max. or 2.5 dBV
	Sensitivity	1004 Hz tone at 900±100 mV_{rms} generates 8kHz deviation.

Table 10: Audio Characteristics

Analog Reference (AGND)

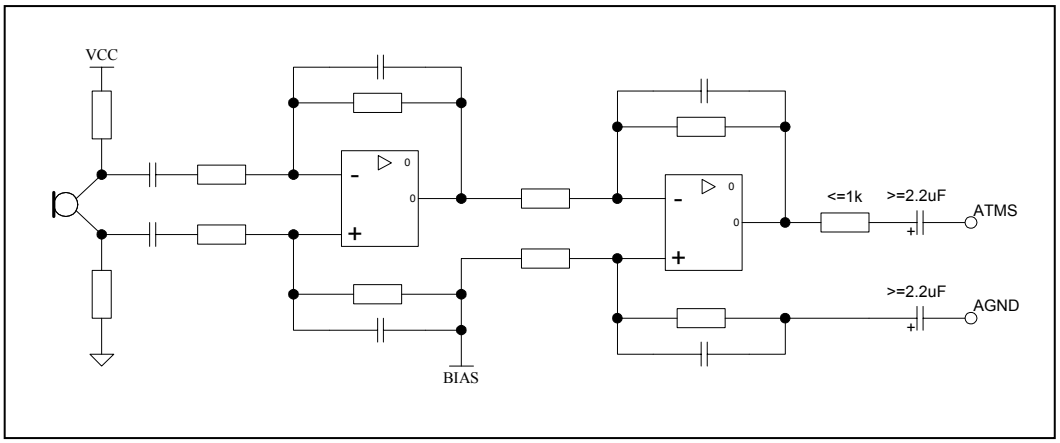
- The AGND lead is the analog audio reference ground. It is the return signal for *Audio To Mobile Station* (**ATMS**), *Audio From Mobile Station* (**AFMS**).
- Electrical characteristics: I_{max} < 40 mA (peak)
- The AGND is connected to the chassis Ground (GND) in the ME, and *only* there. The application should be connected to GND and only use AGND as reference for the audio lines ATMS and AFMS.

Application Implementation:



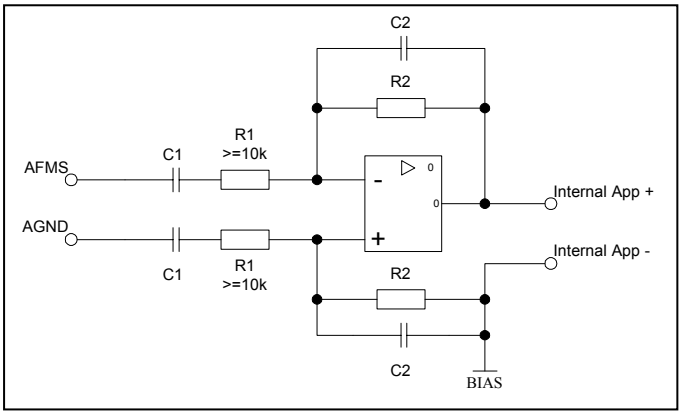
***BIAS**:* An analog ground plane should be generated, which connects to GND in one point so that high frequency digital current is not floating through the analog ground. Connecting the analog ground in only one point also avoids ground currents from power supplies and other high current circuitry from creating noise in the analog circuitry. The voltage supply for the analog circuitry should connect its ground pin as close as possible to the point where the analog ground connects to GND. The BIAS reference is generated from this supply voltage and analog ground, and shall be used as a reference for all analog circuitry in the application. Note that *Analog Ground* and *AGND* are two different signals. *Analog Ground* is the ground plane used by the application. It should be connected to the application's GND in one point preferably at the regulator that generates the analog supply voltage. *AGND* is the analog audio reference received from the phone. This is a signal with the intent to be used together with *ATMS* and *AFMS* as a semi differential interface between the module and the application.

***ATMS**:* An application using the analog audio interface must re-reference the signal from its own internal BIAS to AGND. The figure below shows an example of a microphone implementation.



The microphone should preferably be connected to its pre-amplifier differentially, which will minimize noise pickup from possible ground current.

***AFMS**:* An application using the analog audio interface must re-reference the AFMS-signal from AGND to its own internal BIAS. The figure shows a differential implementation. C1 is chosen to create the correct HP frequency response. R1 and R2 determine the gain, and C2 and R2 determine the LP frequency response.



2.3.4.2 Digital Audio

The CM-42 provides digital audio capability over the system connector. The digital audio signals enable the connection of a digital audio source. The receiver is bypassing the analog audio processing functions performed within the module. The digital audio interface includes the following PCM signals:

Pin	CM-42	Description
17	PCMCLK	PCM Clock Output from module.
18	PCMSYNC	PCM Frame Sync from module
19	PCMULD	PCM Voice Input to module.
20	PCMDLD	PCM Voice Output from module.

Table 11: CM-42 Digital Audio Signals

Already defined CMOS output/input electrical characteristics apply (see Section 2.3.2 above).
The PCM format (for **PCMULD and PCMDLD**) follows a linear PCM data format with 13-bit data embedded in a 16-bit word. The data bits in **PCMULD** (input) and **PCMDLD** (output) are aligned so that the MSB in each word occurs on the same clock edge. See timing diagram in Figure 6.

2.3.4.2.1 Data Format

The CM-42 module implements a 13-bit PCM with the 13-bit data embedded in a 16-bit word as follows. Each PCM word shall contain 16-bits D15 – D00. D15 – D03 is the 2´s-complement value of the 13-bit PCM, with D15 as the sign bit. D15 is the MSB while D03 is the LSB. Note that the MSB is sent in first place. Ensure that the read data from PCMDLD is right shifted three times and sign extended before being used

13-bit linear															
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB												LSB	X	X	X

Bit		Contents
D15 D03	–	Two complement of the 13-bit PCM.
D02 D00	–	Bits are undefined.

2.3.4.2.2 Timing

Timing shall be according to the following diagram (see Figure 6). The signals in the diagram shall be interpreted according to the following relation.

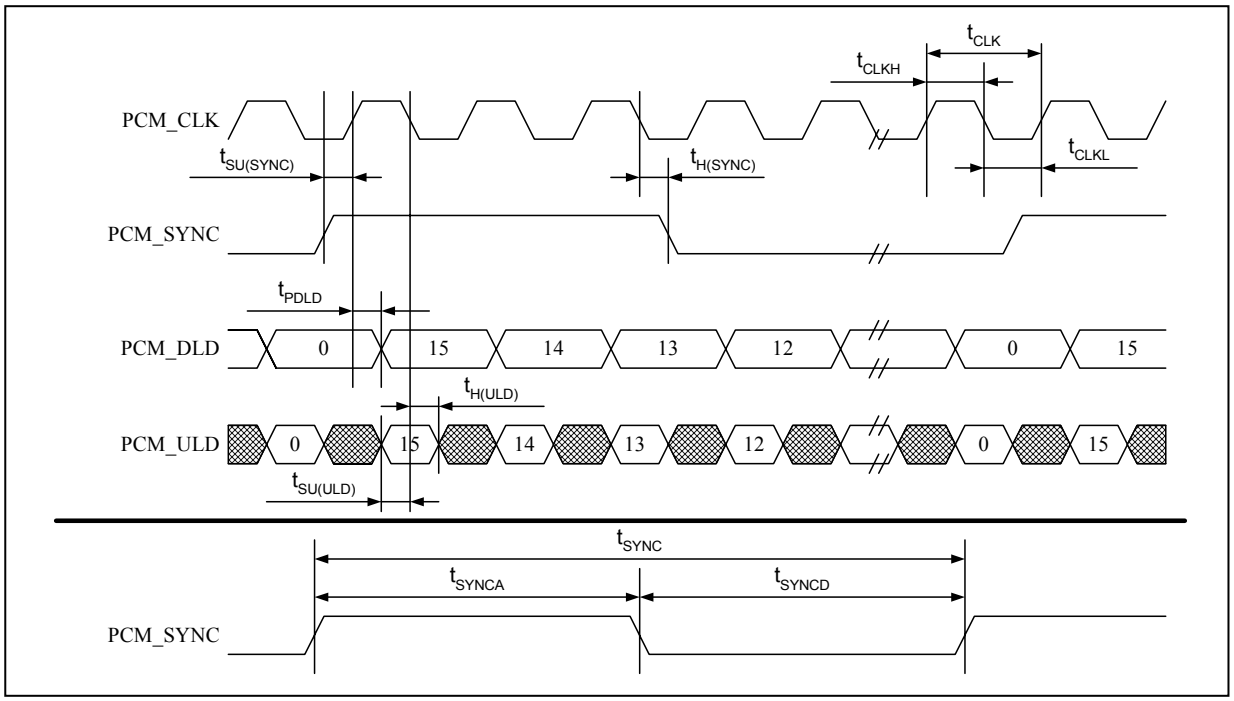


Figure 6: PCM Timing Diagram

The meaning and value of the timing parameters are described in Table 12.

Name	Description	Min	Typical	Max	Unit
t_{SYNC}	PCM_SYNC cycle time.		125		µs
	PCM_SYNC frequency		8.0		kHz
t_{SYNCA}	PCM_SYNC asserted time.	62.4	62.5		µs
t_{SYNCD}	PCM_SYNC de-asserted time.	62.4	62.5		µs
$t_{SU(SYNC)}$	PCM_SYNC setup time to PCM_CLK rising.	1.95			µs
$t_{H(SYNC)}$	PCM_SYNC hold time after PCM_CLK falling.	1.95			µs
t_{CLK}	PCM_CLK cycle time.		7.8		µs
	PCM_CLK frequency		128		kHz
t_{CLKH}	PCM_CLK high time.	3.8	3.9		µs
t_{CLKL}	PCM_CLK low time.	3.8	3.9		µs
t_{PDLD}	Propagation delay from PCM_CLK rising to PCM_DLD valid.			50	ns
$T_{SU(ULD)}$	PCM_ULD setup time to PCM_CLK falling.	70			ns
$T_{H(ULD)}$	PCM_ULD hold time after PCM_CLK falling.	20			ns

Table 12: PCM Timing Parameters

2.3.5 Serial Data Interface

The serial channels are used as asynchronous communication links between the application system and the module. The following table shows the serial data channels related signals:

Pin	CM-42	Description	Dir
23	DCD	**D**ata **C**arrier **D**etect This signal is set default high. It goes low indicating that a data or fax call is established (CONNECT received from the remote modem). The signal goes high when the data connection is disconnected.	O
25	CTS	**C**lear **T**o **S**end This signal is initially set high, indicating that the module is not ready to receive data. It is set low after the module is done performing its startup procedure indicating that it is ready to receive data.	O
26	DTR	**D**ata **T**erminal **R**eady This signal should be set high by the application during a data call. A high to low transition will terminate the data call.	I
27	TD	**T**ransmit Serial **D**ata To Module (DTMS) The application shall set this signal high at startup.	I
28	RTS	**R**equest **T**o **S**end The application shall set this pin low when it is ready to receive data.	I
30	RD	**R**eceive Serial **D**ata From Module (DFMS) The module will set this signal high at startup.	O

Table 13: Serial Data Channels

All the serial-channel-related signals have the same electrical characteristics. In the following table you can see some of these characteristics.

The common CMOS electrical specifications defined in Section 2.3.2 above are valid for all these signals. The standard character format is 1 start bit, 8 data bits, non-parity and 1 stop bit. In all, there are 10 bits per character.

Note! The signal levels do not match the standard RS-232 (V.28). If the application signal levels are not compatible with the CMOS levels described in Table 2, then electrical protection level limiters or level conversion hardware will be necessary between the CM-42 module and the application.

2.3.6 General Purpose Signals

The module provides two general-purpose binary inputs, two general-purpose binary outputs and four general-purpose input/outputs on the system connector.

The AT*EGPI command described in the CM-42 AT Command Manual, allows an application to query the states of the two general-purpose binary inputs.

The AT*EGPO command described in the CM-42 AT Command Manual, allows an application to query or set the states of the two general-purpose binary output inputs.

The AT*EGPIO command described in the CM-42 AT Command Manual, allows an application to query or set the states of the two general-purpose binary input/output signals.

Pin	CM-42	Description
1	IO_1	General Purpose Binary Input/Output # 1 - Reserved
3	IO_3	General Purpose Binary Input/Output # 3 - Reserved
4	IO_4	General Purpose Binary Input/Output # 4 - Reserved
11	INPUT1	General Purpose Binary Input # 1
13	OUTPUT1	General Purpose Binary Output # 1
14	OUTPUT2	General Purpose Binary Output # 2
16	INPUT2	General Purpose Binary Input # 2

Table 14: General Purpose Signals

The general-purpose output signals, OUTPUT1 and OUTPUT2 are CMOS complementary outputs with +/-2 mA drive.

The general purpose input signals, INPUT1 and INPUT2 are CMOS Schmidt inputs.

The general-purpose input/output signals are programmable CMOS I/O. When programmed as inputs, they are configured as Schmidt inputs with a pull-up resistor >20k. When programmed as outputs, they are capable of driving +/- 2mA.

2.3.7 System connector IO functionality

Note 1: The application IO can be one of the following listed types:

- I Logic input (no pull up or pull down resistors required).
- IOC Logic open-collector input.
- O Logic output (no pull up or pull down resistors required).
- OOC Logic open-collector output.
- I/O Logic I/O.

The pin direction in this table is seen from the application's point of view.

Group	Pin No	Name	Application Requirements	App I/O
Data	**HW flow control is by default enabled in the phone module.**			
	27	TD (DTMS)	Logic output to phone module. The application shall set this output active high upon startup.	O
	30	RD (DFMS)	Logic input from phone module.	I
	28	RTS	Logic output to phone module. Pulled down by the phone module (R > 20k). The application shall set this pin active low when ready to receive data.	O
	25	CTS	Logic input from phone module. This signal is initially set high, indicating that the phone module is not ready to receive data. It is set low when the phone module is ready to receive data.	I
	26	DTR	Logic output to phone module. This signal is pulled up in the phone module (R > 20k). This signal should be set high by the application during a data call. A high to low transition will terminate the data call. This signal is asserted (logic high) by the application when it wishes to open a communications channel. The phone module then prepares the modem to be connected to the telephone circuit, and, once connected, maintains the connection. When DTR is de-asserted (logic low), the phone module is switched to "on-hook" to terminate the connection.	O
	23	VPPFLASH/DCD	**DCD:** Logic input from phone module. This signal is set default high. It goes low indicating that a data or fax call is established, (CONNECT) received from remote modem. The signal goes high when data connection is disconnected. Sent from the phone module (DCE) to the application (DTE) to indicate that it has received a basic carrier signal from a (remote) DCE. **VPPFLASH:** The application shall not apply a voltage to this pin unless they intend to use it as VPPFLASH in which case it becomes a power output.	I/O

Group	Pin No	Name	Application Requirements	App I/O
PCM	19	PCMULD	Logic output to phone module.	O
	20	PCMDLD	Logic input from phone module.	I
	18	PCMSYNC	Logic input from phone module.	I
	17	PCMCLK	Logic input from phone module.	I
Analog Audio	9	AGND	Analog reference. This signal is an analog reference output by the phone module. This signal is connected to GND in one place in the phone module. Under no circumstances shall it be connected to any ground or be used as ground in the application. See 2.4 for more detailed information.	I
	10	ATMS	Single ended audio output to phone module.	O
	7	AFMS	Single ended audio input from phone module.	I
Status	12	MODULE_PWR_EN_B	Logic open collector output that is set low by the application to enable power to the phone module. The pull-up resistor resides in the phone module.	OOC
	2	VREF	Phone module logic voltage sense input to application. This signal provides the application with the logic system voltage level used by the phone module.	I
	40	RI	This signal is used to indicate to the application of an incoming call (voice, data, etc.). A falling edge indicates incoming call. The signal remains low for one second, then high for three seconds. This is repeated until call is answered or dropped.	I
	24	RINGER	Pulse Modulated logic input from phone module. The application must provide power amplification if the current draw is expected to exceed 1mA.	I
	15	HW_SD	Bi-directional signal, default set to be an open collector output from the application.	OOC I
Unused	39	CFMS	No termination. Leave open.	I
	37	CTMS	No termination. Leave open.	O
	36	Reserved	No termination. Leave open.	IOC
	35	Reserved	No termination. Leave open.	IOC
	38	Reserved	No termination. Leave open.	O
	4	IO_4_VRTC	No termination. Leave open.	I/O
	3	IO_3	No termination. Leave open.	I/O
	1	IO_1_TIMEMARK	No termination. Leave open.	I/O
Reserved	13	OUTPUT1	No termination. Leave open.	I
	16	INPUT2	No termination. Leave open.	O
	11	INPUT1	No termination. Leave open.	O
	14	OUTPUT2	No termination. Leave open.	I

Table 15: Pin Direction for General Purpose Signals

2.3.8 Recommended Circuitry

Abbreviations:

- VCC - Represents the logic supply voltage used by the application.
- VREF - Current amplified reference voltage used as supply voltage for all logic interface circuitry.

Component proposals:

- Transistors not showing a base resistor should be interpreted as a BRT (Built in Resistor Transistor) i.e. Toshiba RN1308.
- The inverting buffers should preferably be Schmitt-Triggered, i.e. Toshiba TC7S14 or similar.

2.3.8.1 Status Group Recommended Circuitry

The status group contains four signals, one output signal from the application and three input signals to the application.

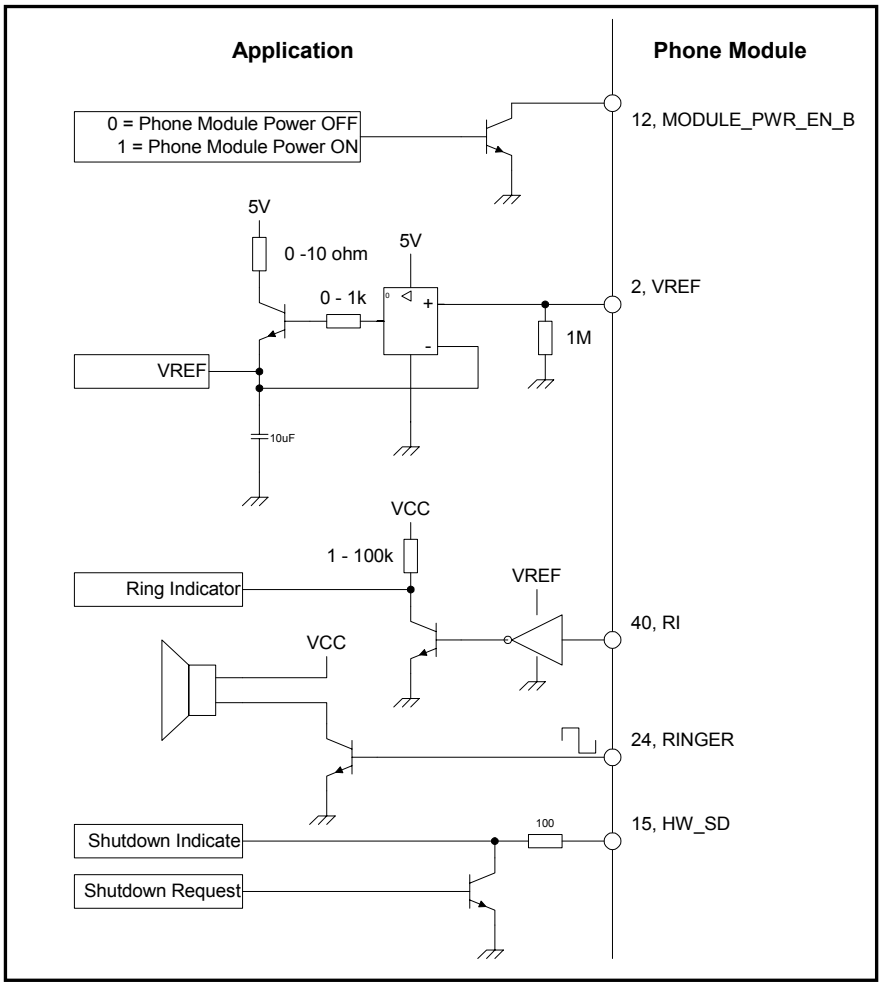


Figure 7: Status Diagram

2.3.8.1.1 MODULE_PWR_EN_B

This signal, located on pin 12 in the system connector, enables the main 5V supply in the phone module so that it powers on. This is an open collector input to the phone module. Its reference voltage is the main 5V supply.

2.3.8.1.2 VREF

This signal, located on pin 2 in the system connector, provides the application with its logic supply voltage. The application can current-amplify this signal and use it to supply its interface circuits.

2.3.8.1.3 HW_SD

This signal, located on pin 15 in the system connector, provides the ability of performing a hardware shutdown of the module. It is a bi-directional signal that is pulled up inside the phone module.

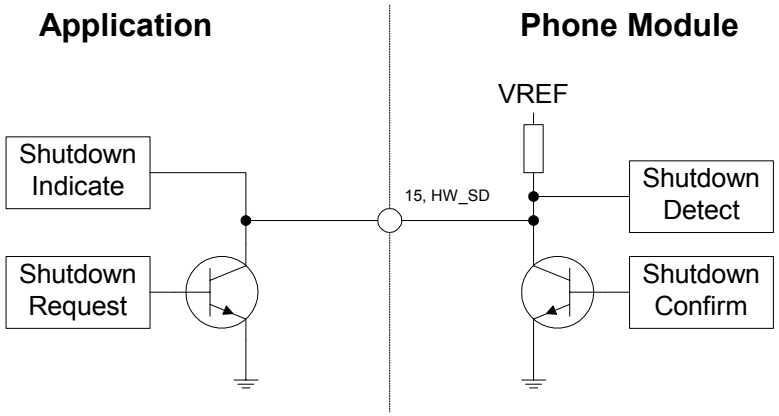


Figure 8: HW_SD Diagram

Shut down sequence:

1. To request a shutdown of the phone module, the application should provide an active low pulse of 100 ± 25 ms on the HW_SD pin through an open collector output.
2. This pulse is detected by the module, which confirms the request by enabling its HW_SD output, setting it active low.
3. The application waits for the HW_SD pin to become inactive high.
4. The module has performed its power down sequence and disables its output resulting in HW_SD becoming inactive high.
5. The application shuts down, disabling MODULE_PWR_EN_B.

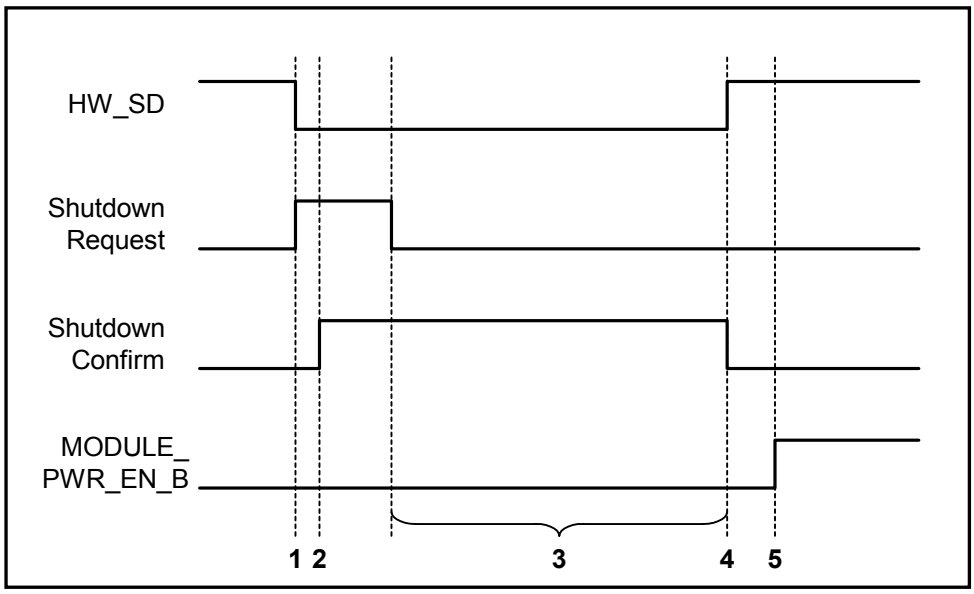


Figure 9: Shutdown Sequence Diagram

2.3.8.2 Data Group Recommended Circuitry

The data group contains six signals, three output signals from application, two input signals to application, and one I/O signal.

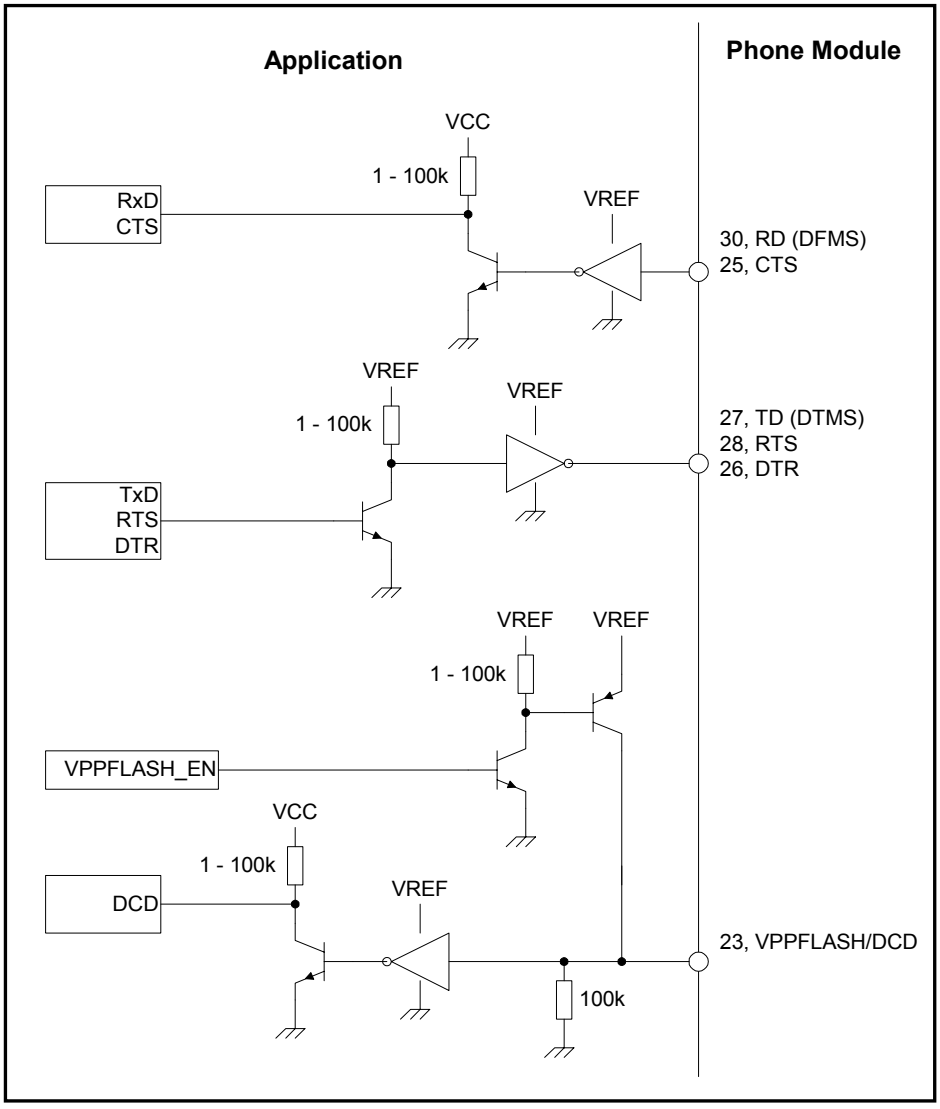


Figure 10: Data Group Diagram

2.3.8.2.1 VPPFLASH/DCD

This signal, located on pin 23 in the system connector, can be used by the application to enable flashing of the phone module. To enter flash-mode, the application shall set VPPFLASH_EN active high, then enable the MODULE_PWR_EN_B pin.

2.3.8.3 PCM Group Recommended Circuitry

The PCM group contains four signals, three input signals to the application, and one output signal from the application.

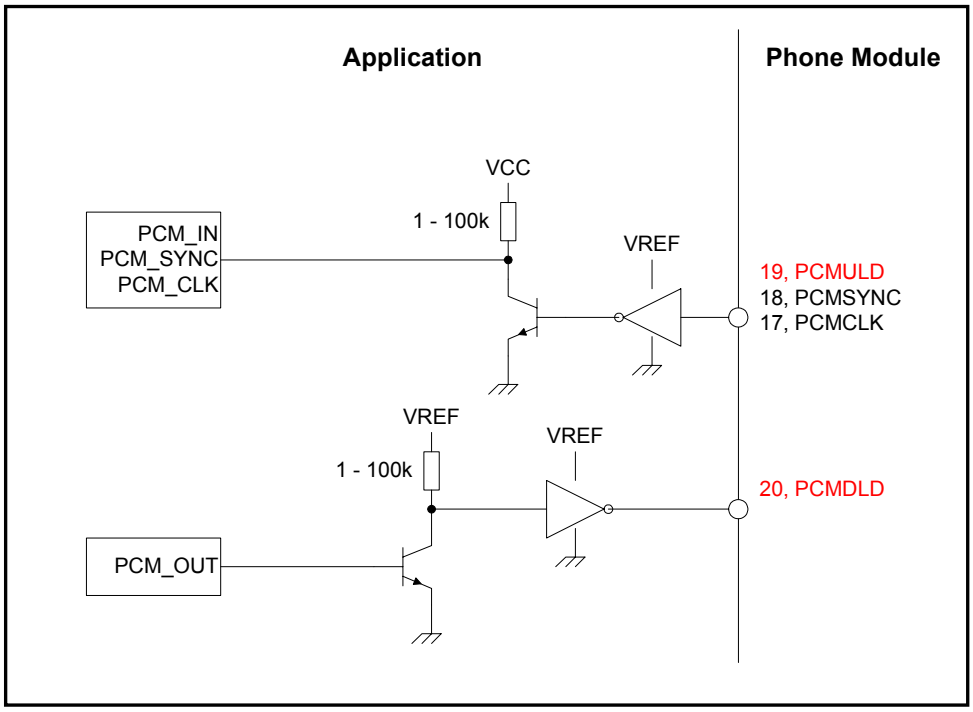


Figure 11: PCM Group Diagram

2.3.8.4 Analog Audio Group Recommended Circuitry

2.3.8.4.1 Creating an analog ground

An analog ground plane should be generated, which connects to GND in one point so that high frequency digital current is not floating through the analog ground. Connecting the analog ground in only one point avoids ground currents from power supplies and other high current circuitry from creating noise in the analog circuitry. This common point should be located where the analog supply voltage (VANA) is generated (at filter (A), or regulator (B) depending on implementation).

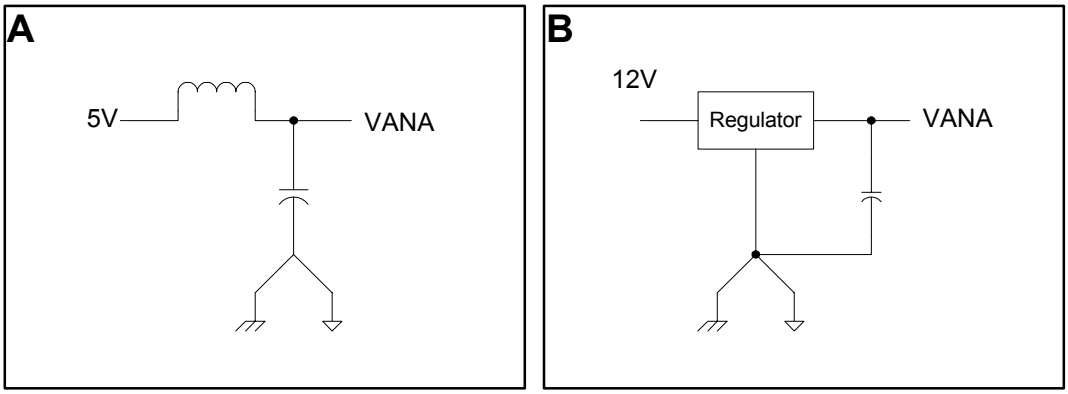


Figure 12: Analog Ground Plane Diagram

2.3.8.4.2 Creating an analog reference voltage (BIAS)

The BIAS reference should be generated from the analog supply voltage (VANA) and be referenced to the analog ground. This reference shall be used to bias all analog circuitry in the application.

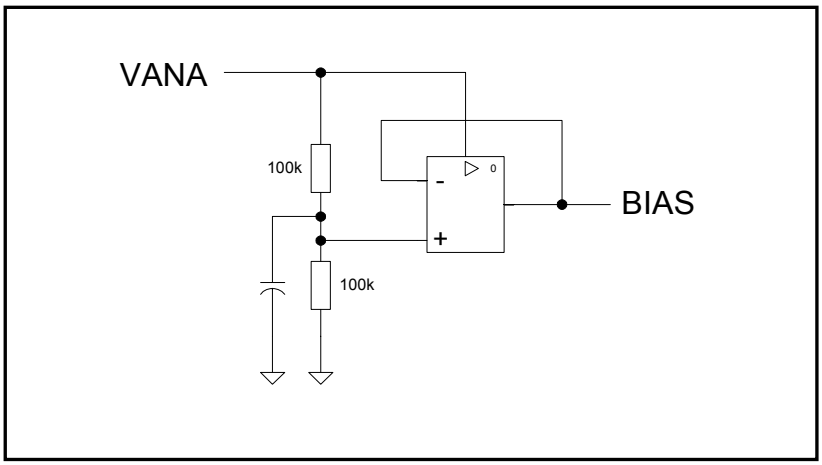


Figure 13: BIAS reference Diagram

The bias can be tapped directly from the resistor voltage divider, but the amplifier will make the bias more stable and less susceptible to noise.

2.3.8.4.3 Analog ground vs. AGND

The AGND signal output from the module is not a ground. It is an analog reference, which is connected to the main ground used by the module in one place inside the module. It should not under any circumstances be used as a ground or connected to a ground in the application.

AGND must be treated as a signal. Together with ATMS and AFMS it creates a semi differential interface.
The analog ground shall be used as ground plane for the analog circuitry of the application. It should not be connected to the AGND signal output from the phone module.

2.3.8.4.4 Microphone path

An application using the analog audio interface must re-reference the signal from its own internal BIAS to AGND received from the module.
The figure below shows an example of a microphone implementation.

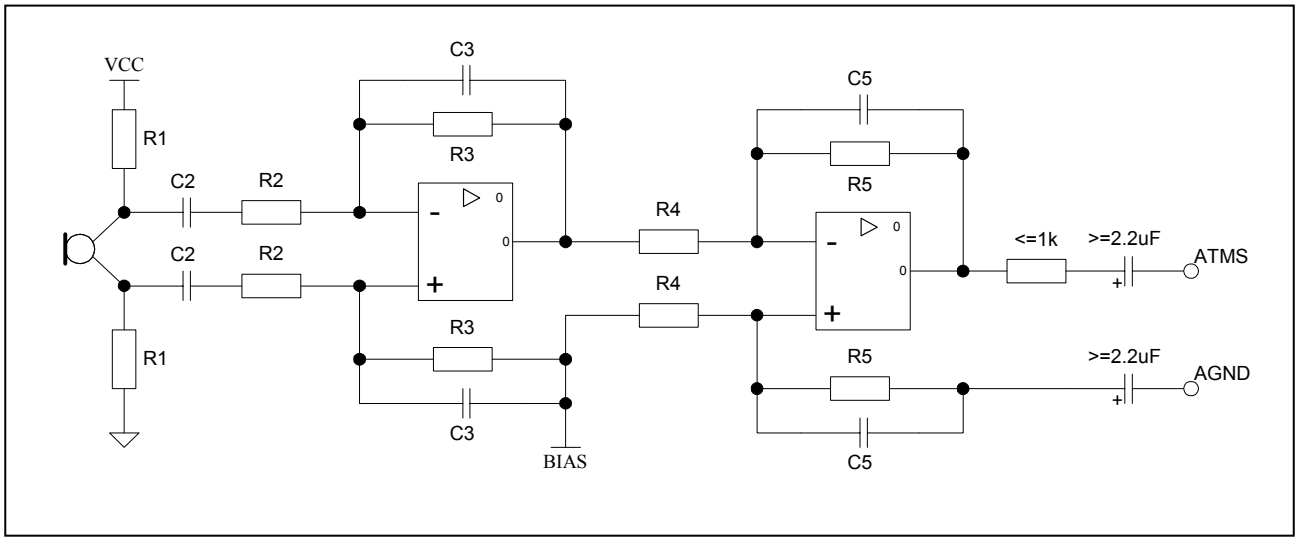


Figure 14: Microphone Path Diagram

The microphone should preferably be connected to its pre-amplifier differentially, which will minimize noise picked up along the way from the microphone to its amplifier. If the impedance is the same on both microphone lines, and the lines are run in parallel, the same amount of noise is picked up on both lines. This noise is then removed in the differential amplifier stage.

2.3.8.4.5 Loudspeaker path

An application using the analog audio interface must re-reference the AFMS-signal from AGND to its own internal BIAS. The figure shows a differential implementation. C1 is chosen to create the correct HP frequency response. R1 and R2 determine the gain, and C2 and R2 determine the LP frequency response.

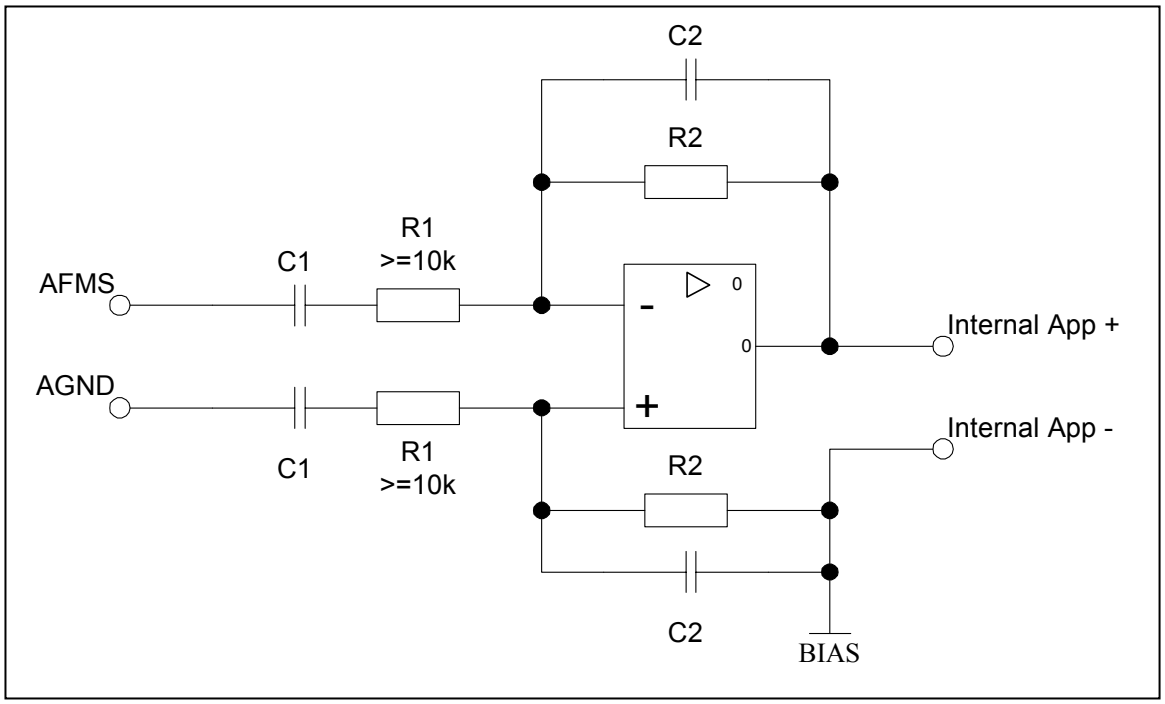


Figure 15: Loudspeaker Diagram

2.4 Antenna Connector

A variety of antenna connectors are available for the CM-4X module including SMA, SMB, MCX, and BNC. A standard 5-pin, thru-hole pattern has been selected because of the wide variety of compatible connectors available and also for the maximum mechanical strength. For applications where a bulkhead connection is required, an end-launch SMA is also available. For automotive applications, a FAKRA-type connector is available which provides a double locking mechanism as well as a keyed, color-coded interface as shown below:

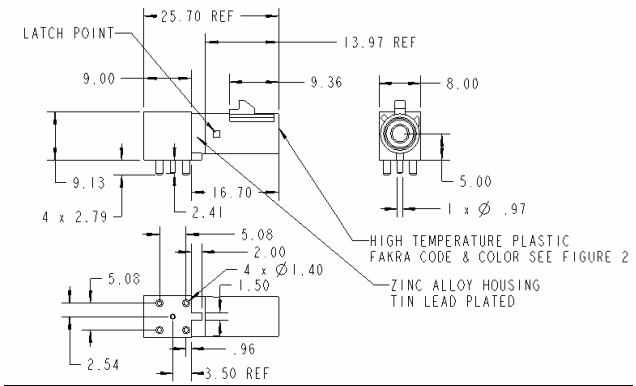


Figure 16: FAKRA Connector Detail

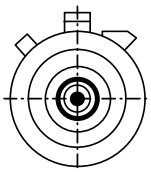
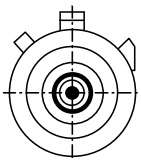
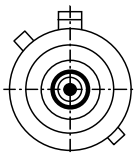
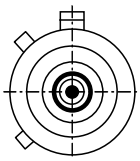
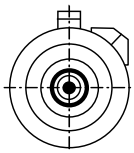
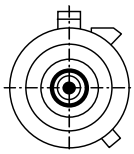
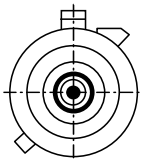
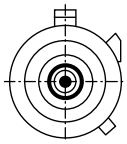
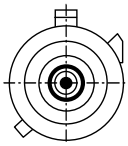
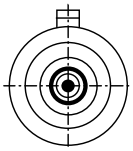
A Black	B Natural	C Blue	D Violet	E Green	F Brown
					
G **Gray**	**H** **Violet**	**I** **Beige**	**K** **Curry**		**Z** **Waterblue**
					

Figure 17: Overview mechanical and color-coding

The physical dimensions of a sample SMA connector and mounting hole are shown in the drawing below.

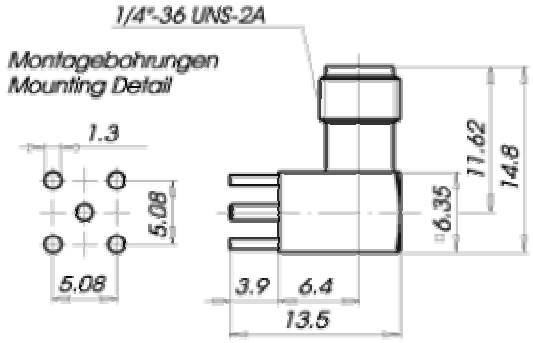


Figure 18: SMA Right Angle Through-Hole Connector
(Dimensions are in mm)

Electrical performance parameters are valid only when the terminating impedance at the output of the antenna connector exhibits a VSWR of less than 2:1 for all phase angles in the frequency band of operation. High VSWR loads at the antenna connector adversely affect current consumption, linearity, and power efficiency of the module and may degrade operation; however, internal protection circuitry has been added to the design to prevent damage.

2.5 Antenna Diagnostics

The antenna diagnostics function consists of one antenna detection circuit per RF connector. Each detection circuit can support antenna resistance values of 1K to 20K ohms. AT commands are provide to query the status, query the limits and set the limits for the status: GOOD, OPEN, or SHORTED. These commands are detailed in the CM-42 AT Command Manual.

The drawing below is a high level description of the antenna detection circuit.

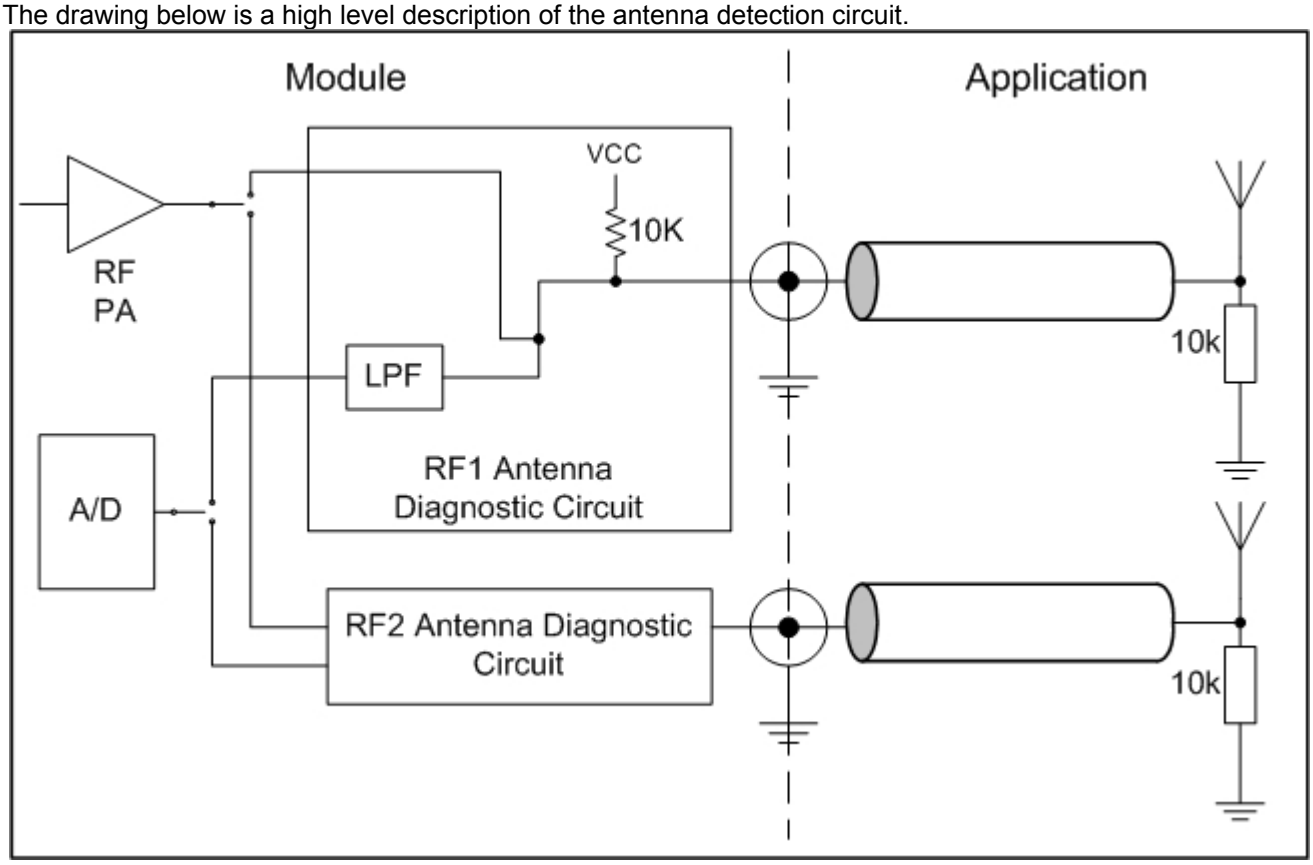


Figure 19: Antenna Detection Circuit

The current antenna status is based on a comparison between the voltage measured at the antenna connector and the limits set by the application for OPEN and SHORTED.

3 Functional Description

This section describes the functionality capability of the CM-42 module. The module performs a set of telecom services according to TIA/EIA-IS-2000. The functions of the display and keypad, usually used to make calls, are implemented by issuing AT Commands over the serial interface. To find out how to send SMS messages, make data calls, use the burst mode services and handle the Phone Book.

3.1 Speech Calls

In this prototype version of the module basic voice calls are supported over CDMA and AMPS.

The module offers the following telecom services:

- **Telephony** according to TIA/EIA/IS-2000.
- **Emergency** according to TIA/EIA/IS-2000.

An incoming call is indicated by a unsolicited response code (RING indicator).

The audio input and output signals in the interface (AFMS and ATMS) will carry analog speech in full duplex (transmitting and receiving simultaneously). The module supports both Full-Rate speech coding and Enhanced Full-Rate (EFR), if EFR is available in the network.

3.2 Value Carrier Services

The module supports the following value carrier services:

- **Caller ID.** Enables/disables the caller's ID from being sent to the called party.
- **Call Forwarding.** Permits the called module to have the network send incoming calls to a desired phone number
- **Call Waiting.** Permits the module to be notified of an incoming call, for example, if the module is engaged in an active call. The module can accept, reject or ignore the incoming call.
- **3-Party Conference Calls.** Permits the module to maintain simultaneous communication with more than one party
- **Call Diversion.** Forward the incoming call only if no answer after a specific number of rings.
- **Voice Mail.** Permits the module to activate / deactivate voice mail. In addition, retrieve voice mail held for the user.

Note! **Some value carrier services as Call Forwarding and Call Waiting may vary depending on your service provider's network. Value carrier services are activated / deactivated via the ATD command using a specific code. This code might vary depending on the service provider. Consult your service provider for further information.**

3.3 Short Message Services

The module provides the functional capability to create and send text messages (MO), as well as receive text messages (MT) across the air interface. The data format can be either string data represented as printable IRA characters, or binary data represented as hex-coded octets.

The key management attribute of a short message is the folder in which it resides. Folders are convenient groupings of similar messages. For example, common folders are in-box, out-box and hold-box. This pool of folders use a common set of indices (internally controlled) to reference each message location. The incoming messages are stored in non-volatile memory until deleted by the host application using the AT+CSDM command.

The maximum length of data sent in an SMS transmission is 255 bytes; the actual user data is directly dependent upon how much message overhead is present. Typically the user data length is around 200 bytes, however if a significant number of optional SMS header data fields are used the user data may be much smaller.

3.4 Services for Short Message Control

The services provided by the module for short message control are the followings:

- Message formatting – The module formats short messages for transmitting over the air interface.
- Message storage – The module stores messages received over the air interface in an in-box; it queues messages for transmission over the air interface in an out-box.
- Default information element storage – The module stores default information elements for use in formatting short messages.
- Message reference assignment – The module assigns message reference numbers to new short messages that are transmitted over the air interface.
- Message index assignment – The module assigns message index numbers to messages received over the air interface.
- Privacy Management – The module supports privacy criteria.
- Message reporting – The module reports incoming messages received over the air interface.

3.5 Data Functionality

CM-42 data services are based on the standard "TIA/EIA Interim Standard, Data Service Options for Wideband Spread Spectrum Systems" (TIA/EIA/IS-707), which is designed to provide async data, fax, and packet data transfer at various data rates. Applications, such as file transfer, Internet browser, Fax, and dial-up networking are further running on top of these data transfer mechanisms through a CDMA wireless network.

More specifically, the following CDMA data service options are to be supported:

CDMA Data Service	Service Option	Rate
Async Data	4	9600
Async Data	4100	Default Rate set 1
Async Data	12	Default rate set 2
Fax	5	9600
Fax	4101	Default Rate set 1
Fax	13	Default Rate set 2
Low Speed Packet Data	7	Default Rate set 1
Low Speed Packet Data	4103	Rate Set 1 (default) or Rate Set 2
Low Speed Packet Data	15	Default Rate set 2
High Speed Packet Data	22	Default Rate set 1
High Speed Packet Data	25	Rate set 2
High Speed Packet Data	33	Up to 153 kbps (to be updated)

Table 16: CM-42 Module Data Services

Note: Rate Set 1: (9600, 4800, 2400, 1200), over the air link rate is up to 9600 bps
Rate Set 2: (14400, 7200, 3600, 1800), over the air link rate is up to 14400 bps

Currently, packet data is only available through Quick Net Connect mechanism before any carrier network supports actual packet data transfer.

3.6 Over The Air Service Provisioning (OTA)

The CM-42 supports TIA/EIA/IS-683-A: Over-the-Air Service Provisioning of Mobile Stations in Spread Spectrum Systems.

4 Hints for Integrating the Module

This section, which gives you advice and helpful hints on how to integrate the CM-42 with the application, should be taken as a guide.

Note! The circuits on the test board are not shielded. Therefore, take proper precautions for avoiding ESD and EMI.

4.1 Precautions

Here is a list of preparations that you should make before beginning the integration work that is described in this section.

- Where to install the module.
- Safety standards
- Network and subscription
- Antenna

4.2 Where to Install the Module

Make sure that the module is installed so that the environmental conditions, such as temperature, humidity, vibration, etc., are not beyond the limits specified for it

Make sure that the signal strength is sufficient. To improve signal strength, move the antenna to another position. Signal strength may depend on how close the module is to a radio base station. Degradation in signal strength could be a result of disturbance from another source, for example, an electronic device nearby.

You can verify signal strength by issuing the AT command AT+CSQ. See the CM-42 AT Command Manual for a description of this and other useful AT commands.

Tip! Before installing the module, use an ordinary mobile telephone to check a possible location for it. Consider signal strength as well as cable length in determining the location for the module and antenna. That way, you will find out if it is practical to install the module where you intended.

4.3 Safety Standards

You are responsible for observing your country's safety standards and the relevant wiring rules, where applicable.

4.4 Antenna

4.4.1 Antenna Type

When choosing an antenna for your application you must consider the following requirements:

- The antenna must be designed for the AMPS/CDMA 800 and CDMA 1900 MHz frequency band (dual band) for the CM-42.
- The impedance of the antenna and antenna cable must be 50 Ω.
- The VSWR value should be less than 2:1.

4.4.2 Antenna Placement

Always follow the instructions supplied by the antenna manufacturer.

You should place the antenna away from electronic devices or other antennas. The recommended minimum distance between adjacent antennas operating in a similar radio frequency band is at least 50 centimetres.

If the module is used in the Class I AMPS mode, a separation distance of at least 20 centimeters must be maintained between the radiating antenna and the user or nearby persons. In this mode of operation, the combined connection cable path loss and antenna gain must also be no greater than 1 dBi.

4.4.3 Possible Communication Disturbances

- **Noise** can be caused by electronic devices and radio transmitters.
- Free Space **Path-loss** occurs as the strength of the received signal steadily decreases with the distance from the transmitter.
- **Shadowing** is a form of environmental attenuation of radio signals that is caused by hills, buildings, trees or even vehicles. Inside buildings this can cause problems, especially if the walls are thick and reinforced.
- **Multi-path fading** is a sudden decrease or increase in the signal strength. This is the result of interference caused when direct and reflected signals reach the mobile phone simultaneously. Flat surfaces such as buildings, streets, vehicles, etc, can reflect signals.

5 Technical Data

Mechanical specifications			
Maximum length:	155.70 mm		
Maximum width:	49.50 mm		
Maximum thickness:	18.97 mm		
Weight:	68.2 g		
Power supply voltage, normal operation	**VCC_MAIN**	**VCC_AUX**	
Nominal Voltage:	5.00 Volts	13.8 Volts	
Voltage range:	4.50 – 5.50 Volts	11.0 – 16.5 Volts	
Radio specifications	**AMPS**	**CDMA (BC-0)**	**CDMA (BC-1)**
Frequency range:	TX: 824 – 849 RX: 869 – 894	TX: 824 – 849 RX: 869 – 894	TX: 1850-1910 RX: 1930-1990
Antenna impedance:	50 Ω	50 Ω	50 Ω
VSWR (Maximum):	2:1	2:1	2:1
Environmental specifications			
Operating temperature range:	-30°C to +70°C: EIA/TIA/IS-2000 -40°C to –30°C: –3dB Degradation beyond –30°C Spec +70°C to +85°C: –3dB Degradation beyond +70°C Spec		
Storage temperature range:	-40 ^{0}C to +85 ^{0}C		
Maximum relative humidity:	95% ± 3% at +40 ^{0}C		
Stationary vibration, random	Acceleration spectral density (m^2/s^2): 0.96 2.88 0.96 Frequency range: 5-10 10-200 200-500 60 min per/axis		
Non-stationary vibration, including shock	• Shock response spectrum I, peak acceleration: - 3 shocks in each axis and direction: 300 m/s^2, 11 ms • Shock response spectrum II, peak acceleration: - 3 shocks in each axis and direction: 1000 m/s^2, 6 ms		
Bump:	Acceleration 250 m/s^2		
Free fall transportation:	1.2 m		
Rolling pitching transportation:	Angle: 35 degrees, period: 8s		
Static load:	10 kPa		
Low air pressure/high air pressure:	70 kPa / 106 kPa		
Phone memory			
Maximum number of entries stored in the phone book.	200		
Maximum number of SMS messages.	128 entries or a total of 16 kBytes of data.		